Machine Learning Based Proximity Operations, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

We propose to create a deep reinforcement Machine Learning (ML) system and development approach that supports certification for mission-critical applications through observable, verifiable architectures and functional safety methodologies, to handle the full scope of onboard, autonomous spacecraft guidance, navigation, and control (GNC). ML systems are currently being used for GNC in many autonomous systems, the biggest investments being for self-driving cars and robotics. We will investigate the feasibility of adopting certification standards based on the latest developments from the automotive industry combined with traditional aerospace certification processes. In Phase 1 we will implement a low fidelity ML-based GNC system in order to demonstrate the viability of the ML approach, whereby the trajectory plan is determined by a neural network and the control loop is executed with an Extended Kalman Filter. This demonstration will inform the drafting of requirements and specifications for a functional safety development framework.

Anticipated Benefits

The ability to reduce costs when exploring complex gravitational environments, (e.g. at uncharacterized asteroids), the communications bandwidth, ground system resources, and labor required to develop and verify the gravity model, trajectories, and failure modes for successively closer passes, orbits, and landings are a significant cost and schedule drivers. The ability to have satellites rendezvous in deep space, possibily for refueling.

Our ProxOps solution will allow for a significant advancement in satellite independence from Earth supervision while minimizing spacecraft burden. This AI will significantly reduce the risk and cost associated with operating spacecraft close to a small asteroid, other satellites, and other planetary bodies by utilizing Real-time mission sequencing and safe proximity operations with near-Earth objects and Satellites.

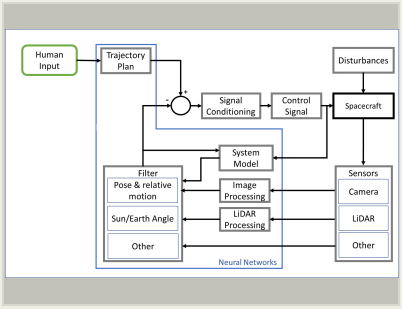

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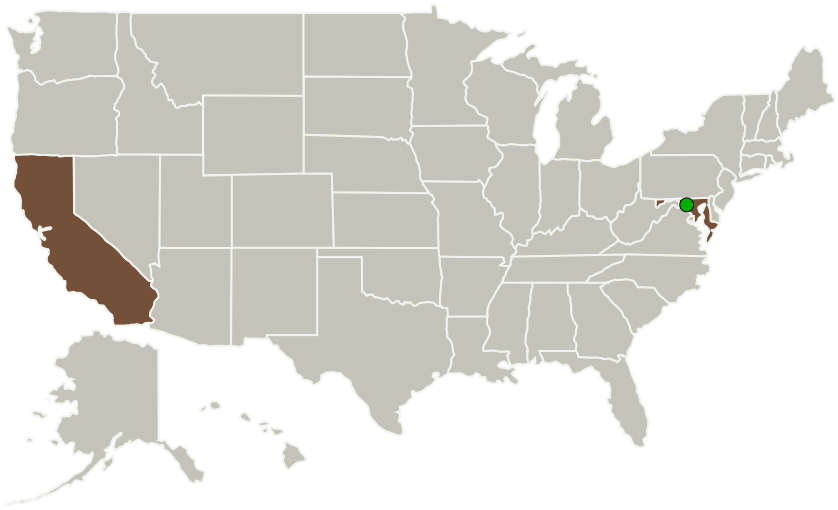
Table of Contents

Machine Learning Based Proximity Operations, Phase I

Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Orbit Fab, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Cupertino, California
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
California	Maryland

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137859)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Orbit Fab, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

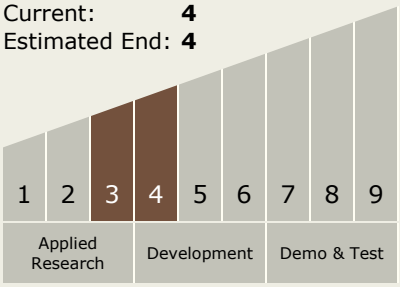
Carlos Torrez

Principal Investigator:

Daniel Faber

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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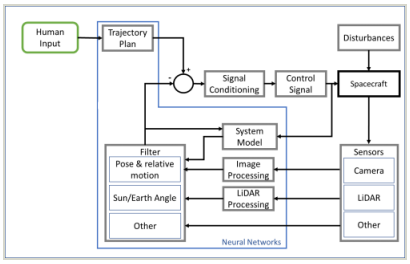
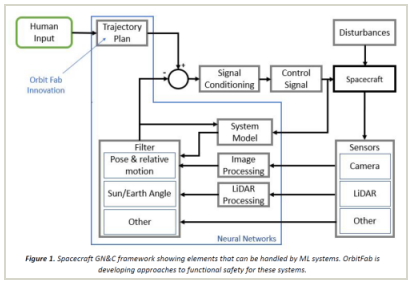
Images



Briefing Chart Image
Machine Learning Based Proximity Operations, Phase I
(https://techport.nasa.gov/image/133255)



Final Summary Chart Image
Machine Learning Based Proximity Operations, Phase I
(https://techport.nasa.gov/image/129405)

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.5 Revolutionary Communications Technologies
    - TX05.5.2 Quantum Communications

Target Destinations

Earth, Others Inside the Solar System